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POLLUTION ABATEMENT POLICY

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AMERICAN SOCIETY OF CIVIL ENGINEERS

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PAPERS

POLLUTION ABATEMENT POLICY

BY THOMAS R. CAMP,[1] M. ASCE

SYNOPSIS

Since the objective of pollution abatement is to reclaim watercourses for appropriate uses, the policy of pollution control agencies should be directed to the maintenance of adequate water quality at least cost and not to the wholesale construction of treatment works. Policy should permit selection of wastes to be treated for greatest over-all economy and should provide for assessment of costs in proportion to amount of wastes produced whether treated or not. Agencies should establish limiting pollution loads allowable at each point of pollution and should reallocate loads when other riparian owners wish to produce liquid wastes.

CORRECTIVE ACTIVITY

The reclamation of streams and other public waters from pollution by municipal sewage and industrial wastes is now receiving some of the legislative attention which is essential for effective abatement of pollution. For generations municipalities and industries in the United States have dumped their liquid wastes into public waters with little regard for the water users unless brought to task by these users through damage suits. Until recently the federal government had no power to compel abatement of pollution and the power of the state agencies was limited generally to the giving of advice. During the depression years the extent to which the despoliation of water resources had been allowed to progress was brought to public attention by the surveys of the National Resources Planning Board. Since then a number of the states have passed laws "with teeth in them" to regulate pollution, and during the summer of 1948 the Eightieth Congress finally passed a water pollution control act known as *Public Law No. 845*. Moreover, since 1940 a number of interstate water pollution control compacts have been concluded. Among the groups administering these compacts are the Interstate Sanitation Commission comprising New York, New Jersey, and Connecticut; the Interstate Commission on the Delaware River (Incodel); the Ohio River Valley

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Water Sanitation Commission; the New England Interstate Water Pollution Control Commission; the Potomac River Commission; and others.

The activity in the planning and construction of sewage and waste treatment works which has resulted from the current interest in pollution abatement is enormous and is on a nation-wide scale. For the first time real progress is being made on the industrial wastes problem. Some of the necessary legislative tools are available and the future is hopeful for the eventual cleanup of streams in the United States. The major part of the task is still ahead, however, and the hardest "nuts" have yet to be "cracked." The current boom in pollution control activities has brought many people and groups into the field who are novices in sanitary engineering problems. At the one extreme, there are strong pressure groups interested in sports and wild life who appear to believe that pollution can be abated completely; and at the other extreme, there are some manufacturers who are fighting to maintain the unhampered use of public waters for the disposal of wastes. The great diversity of interests represented by these newcomers and the lack of understanding on the part of many of them of the technical nature of the problems to be solved are producing a "crazy quilt" of pollution abatement policy. It is necessary to take stock of this situation now and to work for sane and sound policies throughout the nation. If economic, equitable, and effective policies are not developed, the entire program may bog down through unwise and wasteful expenditures.

Forming a Policy

The writer has no general plan to offer for what might be called an ideal pollution abatement policy. In fact, he does not believe that it is possible to have one standard pollution abatement policy, or that it is desirable to attempt to standardize. Each problem is unique and should be studied on its merits and each region should adopt policies best suited to its needs. The purpose of this paper is to point out some of the problems encountered in policy making and to suggest some solutions.

One of the prevailing criticisms of the engineering profession is that too few of its members take an active part in public affairs. No group is more vitally interested than are sanitary engineers in this subject and no group is better qualified to guide policy making. The problems involved present a big opportunity, but they are challenging.

The purpose of water pollution abatement is to reclaim waters for several uses by the public and the riparian owners. As a first step in policy making, therefore, it is necessary for the pollution control agency to designate the appropriate uses of each public watercourse or part thereof and to set standards of suitable water quality. This procedure is analogous to zoning in the preparation of a city plan. A number of pollution control agencies have already classified their public waters as to use, and in other areas classification is now (1950) in progress. This work is extremely important and it must be done judiciously if the cost of pollution abatement is to be kept within reasonable bounds. Some watercourses in sparsely inhabited upland areas may readily be reclaimed and controlled for use as drinking water supplies whereas other grossly polluted watercourses in highly industrialized regions can never be

reclaimed to a high degree of purity without economic suicide. The classification policy should be designed to benefit both the public and the riparian owners and should aim at the gradual improvement of all public waters. The policy should be flexible enough to permit changes in classification from time to time as circumstances dictate.

Water Quality Standards

The main uses of public waters in the United States are: (1) Public water supply, (2) fish propagation, (3) recreation and bathing, (4) industrial water supply, (5) agricultural use, (6) water power, (7) navigation, and (8) disposal of sewage and industrial wastes. These purposes are listed in general order of decreasing water quality but not in order of economic importance. The standards of quality of water suitable for some of these uses may be defined in fairly definite terms whereas the quality of water required for some of the other uses is quite variable depending on local circumstances. In any classification program more than one use must be allocated to most of the watercourses, and the standard of water quality for any public water will be determined by the higher uses. Since the conditions of use vary from one region to another, it is understandable that classifications should also vary. A review of the classifications which have already been made by various pollution control agencies reveals a great diversity of opinion regarding the required quality of waters of the various classes. This is a natural result of the diversified use of the waters. If the classifications and standards are soundly drawn up for two adjoining regions, there is no reason why they should be similar, except that agreement must be reached for streams and public waters which are common to both regions.

The two most important characteristics of polluted waters which bear on their use are their contents of coliform bacteria and dissolved oxygen. The coliform count is an index of the concentration of domestic sewage in the water and of the potential hazards from intestinal disease germs. Coliform bacteria emanate almost entirely from the fecal matter in domestic sewage. The dissolved oxygen content of a public watercourse determines its suitability as a habitat for fish life and whether or not it is on the point of becoming septic with the production of black water and foul odors. Oxygen enters the water by solution from the atmosphere. If the dissolved oxygen is not being used up by biochemical reactions in the water, its content will approach the saturation value ranging from about 8 ppm in the summer to about 14 ppm in extremely cold weather. Oxygen contents less than the saturation value indicate that the oxygen is being used up by bacterial decomposition of organic matter in the water. Some decomposable vegetable organic matter enters streams from swampy regions but most of the decomposable organic matter emanates from pollution by municipal sewage and industrial wastes. Hence, the oxygen content in a water is determined primarily by the amount of polluting organic matter.

The coliform count in a water to be used for a public drinking water supply should be less than 1 per 100 ml of sample if the water is to be used without any treatment, less than 50 per 100 ml if the water is to be used after chlorina-

tion only, and less than about 5,000 per 100 ml if the water is to be used after rapid sand filtration and postchlorination. More highly polluted waters may be used with additional treatment. The coliform count of sea waters to be used for shellfish propagation should not exceed 70 per 100 ml, to conform with existing standards of the United States Public Health Service. There is a great diversity of opinion regarding the proper coliform standards for public waters to be used for bathing purposes. This diversity of opinion emanates from the fact that there is inadequate epidemiological evidence to demonstrate the extent to which intestinal diseases are transmitted to bathers in sewage polluted waters. Some authorities insist on a maximum coliform count of 100 per 100 ml whereas others will permit counts up to 2,400 per 100 ml for bathing waters. The safe coliform count for waters to be used for irrigation purposes is not well established and research is needed to determine the safe limits. Irrigation waters to be used on crops which require cooking before eating, of course, may have higher bacterial contents than is the case for crops eaten raw.

The oxygen content of public waters should never be completely exhausted if septic conditions and odor nuisances are to be avoided. If a public water is to be a suitable habitat for game fish, the oxygen content should preferably exceed 5 ppm but should not be reduced below about 4 ppm. For hardy fish such as shad and suckers a lower limit of 3 ppm is sufficient.

There are other less important quality characteristics of public waters which influence their suitability for use. The pH-value, for example, should generally be held within the limits of from 5 to 8.5 if the water is to be used for public water supplies or for the propagation of fish life. The temperature of the water should not be unduly increased by the discharge of hot wastes or condenser water if the watercourse is to be maintained as a suitable fish habitat. For most of the higher uses of public waters, the water should contain no objectionable odor, oil, scum, floating solids, or debris except from natural sources; and it should contain no taste producing substances in objectionable concentrations and no substances in harmful concentrations which are themselves toxic or become toxic in combination with other substances. (Note that these qualities are relative and depend primarily on the concentration of the polluting substances.) It is seldom practicable to specify the complete elimination of any substance. The amount and the character of suspended matter should not be such as to produce objectionable sludge deposits. Inordinate color and turbidity when introduced with polluting wastes are of esthetic importance and are particularly noticeable by the general public. Both color and turbidity so introduced may be reduced by the treatment methods employed for the removal of organic matter and bacteria but the extent to which further treatment is justified economically, solely for the removal of color and turbidity, is questionable.

Critical Stream Flows

The flow of streams is quite variable from the low flows during periods of extreme drought to peak flows during major floods—and the range of flows is much greater in some streams than in others depending on size, the nature of the catchment areas, and the extent of low-flow regulation by storage. It is

evident therefore that the continuous discharge of a definite quantity of some material into a stream may cause pollution at some flows and may not cause pollution at greater flows. In setting the water quality standards it is necessary to state at what flow in a particular stream a limiting standard is to apply. If complete abatement is expected, the flow selected must be the minimum possible at any time. For many streams, something short of complete abatement must be accepted. A study of flow-duration curves will furnish a basis for the selection of critical flows below which some pollution must be accepted.

Limiting Pollution Loads

After the classification of a public watercourse has been established and the standards of water quality have been set, the limiting quantities of each polluting substance which may be discharged into the watercourse at each point of pollution may be estimated. In making such an estimate, analyses must be made of the quantity and the character of each polluting substance and of the water itself. The stream or tidal estuary must be considered as a dynamic moving entity. Due account must be taken of the dilution available, times of flow, deoxygenation and reaeration rates, sedimentation and benthol decomposition, and bacterial die-off rates; and a particular critical regimen of temperature, flow, wind direction, and velocity must be selected to which the water quality standards are to apply. After the limiting quantities are determined, the amounts of removal may be estimated by deducting the limiting quantities from the total quantities being or expected to be discharged into the watercourse.

The removals required during the critical flow periods will determine the size and the extent of the treatment works, and will fix the capital expenditures required therefor. At flows greater than the critical, and during cold weather, a lesser degree of treatment may suffice to meet the water quality standards. Whether such a lesser degree of treatment is permissible is a question of great importance which depends primarily on the nature and the use of the watercourse. In many streams, organic matter which is not removed by treatment during the winter months deposits in ponds or reservoirs to cause trouble during the following summer.

Optimum Enforcement

In a single watercourse the removal required at the critical flow at one point may be totally different from that required at another point. A high degree of treatment may be necessary at some points of pollution and no treatment at all at other points. Once the standard of water quality is set for a particular public watercourse, any degree of treatment of sewage or industrial wastes in excess of that required to meet the standard will result in economic waste. This matter should be emphasized very strongly. It is wrong to require more treatment than is necessary to produce the desired results and it is wrong to require any polluter to treat his wastes or sewage unless such treatment is necessary to produce the desired results at the least over-all cost.

The problem of pollution abatement for a particular watercourse should be studied as a whole to determine which wastes must be treated and which may

be allowed to go untreated for the best economical solution. Pollution control policy should be so developed as to permit the selection of wastes for treatment and to permit the selection of wastes which may be discharged untreated for best over-all economy. This proposal is contradictory to the policies that have been followed by some agencies. Under existing law it is easier for a public agency to enforce a policy that requires treatment by all polluters on a given watercourse, and the same degree of treatment for similar wastes. It seems to the writer that this policy is unreasonable, uneconomical, and dangerous to the over-all program of pollution abatement.

Equitable Assessment of Costs

It is difficult to adopt a policy permitting the selection of wastes for treatment and the selection of wastes that may be discharged untreated. The principal obstacles relate to the assessment of the costs. There is no simple solution. Equitable methods of assessing cost may readily be devised, but legal difficulties must be hurdled before they may be put into operation. It is inequitable, for example, to require one polluter whose wastes are selected for treatment to pay the cost while another, whose wastes are to be discharged untreated, pays nothing. If any polluter is to be assessed, all should be assessed in proportion to the amount of polluting matter each produces, whether their wastes are treated or not.

In a sense, this method of assessment may be considered as a benefit assessment for rights recieved—the right being the right to use a share of the self-purification capacity of the public watercourse. If the matter is considered in terms of benefits, the question arises as to whether the general public should not share in the cost of manufacturing waste treatment since all who use the watercourse share in the benefits resulting from its improvement. It is not equitable, however, for the public to pay the full cost of abatement because such a method of assessment would relieve the polluters who are principally responsible for the pollution from any share in the cost of its abatement and would thus fail to restrain them from unnecessary additional pollution. It is best that polluters be made to pay for abatement in proportion to the amount of polluting matter produced by each to stimulate reduction of the amount of polluting matter produced.

A method of assessment such as the foregoing is difficult to establish unless all the abatement works are owned and operated by a public agency having over-all supervision of the problem. This agency may be a municipality, a district, or (in some cases) the state. There are other advantages in public ownership and administration of all the abatement works, particularly to the industries whose wastes must be treated. Under present law the manufacturers are usually held wholly responsible for the treatment of their wastes and the cost thereof, the pollution control agency acting in a police capacity to compel action. Under such a system the industry is compelled to pay the full cost of nonrevenue-producing capital improvements on short-term financing and must show this cost as a capital investment on its books. Companion bills, *House of Representatives Bill No. 1047* and Senate *Bill No. 244*, were introduced at the first session of the Eightieth Congress to allow deductions in computing net

income for moneys spent by industry for the construction of treatment plants for industrial wastes. No legislation has resulted from these bills.

If works for the collection and treatment of manufacturing wastes are constructed, owned, and operated by a public agency, the construction may be financed by long-term bonds at low interest rates backed by the full credit of the public agency. The costs may then be assessed back against the industries in the form of annual charges all of which may be shown on their books as operating expense and deducted in computing net income. This method of organization, therefore, not only permits the industries to share in long-term financing at low interest rates, but also results in considerable saving to them in income tax. A further advantage to the industries is that they are relieved of the responsibility of going into the business of treatment of their wastes. Except in cases where recovery of valuable by-products is promised, industries have little or no interest in the treatment of their wastes. It is the primary interest, however, of a public agency set up specifically for this purpose.

The methods of assessing the costs of sewerage works which have been developed in the United States over a long period of years are not adequate to meet the problems encountered in pollution abatement. Three methods are in general use which involve: (1) Assessment against the general property tax, (2) betterment assessments against the property served, and (3) sewer rental or service charges. The first two methods were developed for the construction of sewers, and either method or a combination of the two can result in an equitable distribution of the costs of construction and operation of sewers. Payment of the assessments is enforced since the assessments become liens on the properties. The third method, first called a sewer rental charge and now generally referred to as a sewer service charge, was developed primarily to assess the cost of treatment.

Since the cost of treatment of sewage is roughly in proportion to the amount of sewage, the sewer service charges are usually designed for payment in proportion to the amount of sewage. As direct measurement of flow of sewage from each contributor is impracticable, the sewer service charge is usually set up as an additional charge on the water bill. The legality of this method has been questioned and some difficulties have arisen in collections. A recent decision of the Supreme Court of Florida in the case of sewer revenue bonds for the City of Miami validates this method of charge, however, and permits the city to shut off the water for failure to pay sewer service charges. This decision is considered of great importance in that it permits financing of sewerage works by revenue bonds outside the debt limits.

In the writer's opinion this decision is not as important as might be supposed. It does allow the use of revenue bonds for financing outside the debt limit but the method of charging authorized by the decision is not sufficiently flexible to result in equitable assessments of cost against industries. The method does not permit assessing costs of treatment against industries whose wastes are not collected for treatment and it does not permit assessing costs in proportion to the strength of the wastes. In the case of a sewage treatment plant treating only domestic sewage, equitable assessments can result since the cost of treatment is roughly proportional to the flow. In cases where considerable quanti-

ties of industrial wastes may be treated, however, the cost of collection and treatment depends on the amount of biochemical oxygen demand (B.O.D.) and suspended solids contributed as well as on the flow. The cost of secondary biological treatment is almost directly proportional to the B.O.D. content of the sewage and the cost of sludge handling and disposal is almost directly proportional to the suspended solids content. For equitable assessments in such cases, therefore, it is most desirable to be able to assess in proportion to the B.O.D. and the suspended solids produced. The simpler method of charging in proportion to the water bill is not equitable. Another difficulty in cases involving industrial wastes is that in many instances the process water used does not come from the municipal supply but from private sources.

Role of Pollution Control Agencies

Pollution abatement involves processes. The construction of treatment works is only a means to an end and successful abatement requires that operation of the treatment works should be given equal attention. The engineer is primarily interested in the design of processes and in the operation of processes. The works themselves serve only to house these processes. The "processes" that occur in the watercourse itself are just as important as those that take place in the treatment works (and frequently more important). Pollution control agencies should focus their attention on the processes in the watercourses and on the limiting quantities of polluting materials allowed at each point of pollution. Except in cases where the agency is charged with the design and the operation of the treatment processes, the public agency should leave the details of design and operation to the polluter. The control agency should allot to each polluter a definite quantity of polluting substances not to be exceeded at each point of pollution. The procedure by which the required degree of treatment is accomplished should be left to the ingenuity of the polluter. It is wrong to require standard methods of treatment if the polluter can show that he can produce the required quality of effluent by other procedures which he considers less expensive and more appropriate for his use.

In cases where bacterial removal is highly important and B.O.D. removal is of no importance, complete treatment by a biological process should never be required and primary treatment by sedimentation should not be required unless it is absolutely essential to remove suspended and floating material and to make disinfection effective. Where B.O.D. removal is necessary, the process by which this is to be obtained should not be specified by the water pollution control agency. If the polluter is to be required to pay the cost of treatment and to be responsible for the successful operation of the treatment works, he should be left to his own devices as to the type of the treatment. He should be required to demonstrate by laboratory and pilot plant tests, however, that the methods he proposes to use give promise of producing the required results. The activities of the control agency should in such cases be limited to assisting in research and to giving advice.

This paper has advocated that the self-purification capacity of public water be allocated to the various contributors of liquid wastes in such proportions as will produce the required abatement at the least over-all cost. This policy

may be interpreted as an allocation of rights to the riparian owners in the self-purification capacity of the public watercourse. Legal difficulties may be introduced in that these rights are not allocated equally or in proportion to the value of the property served. Other legal difficulties arise because all the self-purification capacity of public water will thus be utilized by those who are now discharging wastes. What is to be done for other riparian owners who wish to build industrial plants producing manufacturing wastes? What is to be done for new residential communities which must produce sewage? What is to be done for the growth of existing industries and existing municipalities? There is only one answer: Reallocation must be made from time to time, for every riparian owner has a right to use the stream for the discharge of his wastes. When reallocations are made, higher degrees of treatment will thus be required of existing users.

It is not right to pass legislation forbidding the establishment of new points for the discharge of wastes into a section of a public watercourse which is already similarly used elsewhere. Such legislation deprives the riparian owners who are not now discharging wastes into the stream from a reasonable use of the stream for the discharge of their wastes. The existing users must be compelled to reduce the amount of their discharges if reduction is essential to permit a reasonable use of the watercourse by other riparian owners who wish to produce liquid wastes.

Conclusion

In conclusion the writer wishes to emphasize the fact that one of the most important uses of public watercourses is for the disposal of sewage and industrial wastes. All sewage and most liquid industrial wastes must eventually reach watercourses, in whole or in part. It is practicable only to reduce the quantities of polluting substances and to redistribute the points at which these substances are discharged. The right to discharge wastes must be defended as strongly as the rights for all other appropriate uses of public waters. Policy problems are difficult. Pollution abatement cannot be achieved by the simple expedient of ordering the wholesale construction of treatment works. At some points treatment will be required, at others it will not be. Satisfactory quality of water in public watercourses is the sole objective of pollution abatement.

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